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Human Aspects of Water Management at Impoverished Settlements. The Case of Doornkop, Soweto

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Abstract: Since 1996, the South African government has undertaken a considerable project to fulfil the proclaimed right of citizens to access sufficient water and sanitation (Government of South Africa, 1996) through traditional water management and water governance. However, democracy has not yet provided significant improvements to informal dwellers. Doornkop (Soweto) is a clear example of a community fighting for its rights to access clean water and adequate wastewater sanitation systems. Beyond traditional water management and social and environmental water governance, an ethical view of managing water policies through principles of "human dignity" and "human equality" has arisen in order to provide basic water services. Equal opportunities to manage water are provided, analysing the impact of the principles of the United Nations Educational, Scientific and Cultural Organisation (UNESCO) upon South African informal communities through the implementation of human water governance. The objectives of the study ascertain if those two principles are relevant to improve the community's living conditions as well as to positively affect the "Principles of water governance" and the "Water principles". With this aim, a case study was set up at Doornkop (Soweto), in which 416 informal dwellers among a relocated group, a tenure group and a squatter group were tested through the Smart PLS method. Results showed that water services can be highly improved through human water management, a model that can be applied to other underdeveloped areas in the world.

Keywords: ethics; human dignity; human equality; informal settlements; water governance; water management; water principles; South Africa

1. Introduction

The global share of the African urban population is expected to rise from 11.3% in 2010 up to 20.2% in 2050, making African cities the second fastest growing cities in the world after Asian cities [1,2]. Unfortunately, the rapid increase in urban population is intertwined with social and cultural inequalities, highlighting the role of those providing basic water services, especially in South African townships.

Tewari [3] remarked that the evolution of water-service delivery in townships and the political history of South Africa are inalienably related. At the beginning of the democratic period in 1994, the country had to grapple with the legacy of colonial and apartheid racial discrimination policy regimes. These sought to justify the racial deprivation of the black majority to equal access to equitable opportunities, education, housing, human dignity, water and sanitation. Those inequalities began once black communities were forced to relocate from well-located urban land to marginal areas on the periphery [4].

In order to reduce those inequalities, the government paid particular attention to water-service delivery [5,6]. Based upon centralised top-down systems, the South African government operated within a water-management regime, facilitated by professional elites, with a rigid regulatory framework. Although it has been relatively successful in the past [7], it is currently being questioned [8] due to the exclusion of communities from participating in their own development [9]. It explains their inadequacy to face the real social challenges based on those inequalities [10].

In order to resolve those previously identified social challenges, the traditional role of "governments" as the single decision-making authority were in many instances replaced by multi-level, poly-centric governance [11]. Public participation had increasingly attracted attention as a decision-making redistribution method that facilitates individuals and groups in taking an active role in making decisions [12]. It also increases the rate of adoption and diffusion of new decisions among targeted groups, as well as the enhancement of the capacity to meet local needs and priorities, such as resolving inequalities [12,13]. Bottom up decentralised water governance improved people's living environment by acknowledging and responding to their needs and priorities [14,15].

Nevertheless, this approach, that went far beyond traditional co-ordination and planning activities [16] and engaged local people in decisions affecting their water resources and governance challenges [17], is not robust enough to tackle constant emerging water challenges [18]. Those challenges, specifically focused in the particular case of South African townships, were based upon the potential abuse of the concept to over-allocate water to privileged groups at the expenses of other people and the lack of clear responsibility and capacity for implementation by governments [19].

These consequences meant that human rights approaches had little practical impact on the mitigation of inequality in water distribution in South African informal settlements [19,20]. Those public services at the periphery lacked access to fresh water, access to improved sanitation facilities, structural quality and durability of dwellings, and the security of tenure [21]. As opposed to the white suburbs, those informal settlements lacked vital urban elements and services, as can be proved by their rudimentary infrastructure [22]. Those inequalities rose sharply during the period of South African apartheid [23].

In the City of Johannesburg, as a good representative case for the country, the municipality became responsible for ensuring that all of its residents had access to safe drinking water within 200m from their household [24]. As the municipal authority, the City of Johannesburg was also responsible for sanitation services as well, which was established in January 2001 as an independent company from the government [25]. Inequality was evident in the city of Johannesburg, where racially focused spaces were created for white, black, Indian and coloured residential areas [26]. The inability to provide basic services resulted in widespread protests over the failure to deliver water, sanitation, electricity and, mostly, housing [27]. This distinction between wealthy and poor is not, however, uniform in Soweto, the biggest district of Johannesburg. The neoliberal model of management supply has, thus, created new mechanisms of instituting inequalities within society [28].

An ethical view of managing water policies through social innovation has been addressed by meeting social needs in communities, which provide a new view of water management. This is called human water governance whose aim is mainly based on providing equal opportunities and innovative abilities to informal settlement dwellers regarding the management of water.

This research has a twofold purpose: (1) to measure the level of importance that dwellers in community gives to access to water services; and (2) based on the data collected from the community dwellers, to set up a water utilisation model for South African impoverished informal settlements following the principles of the United Nations Educational, Scientific and Cultural Organisation (UNESCO).

In this paper, the authors have firstly studied the "Human Water Principles" (HWP) based on the dignity and equality of each informal dweller and secondly, the five "Water Principles" (WP), and finally the "Principles of Management" (PWM) that engage the community by implementing their participation in public water policies.

1.1. A Case Study: Inequalities at Doornkop, Soweto

To tackle water issues, the South African government proposes that municipalities require support to maintain a minimum level of services, while the communities themselves would fund the operational costs. Similarly, Art. 36 of the National Water Act [29] stipulates the needs to improve water supply within impoverished settlements. However, in spite of the fact that sustaining a basic services investment programme by the municipalities through decentralised water policies, access to potable water and sanitation services have still not reached impoverished communities. Municipalities lack the administrative and technical capability to implement such a water policy, and as such 130 out of 284 South African municipalities need support to meet their minimum obligations [30].

The ability of the state to effectively manage and control water resources remains problematic. The traditional top-down approach that carried out radical changes [31] in water supply and sewage disposal is still in question.

This is the case of Doornkop (Soweto), located in Region 6 of the 11th new City of Johannesburg regions. The western boundary of Region 6 is beside Ward 50 of the Metropolitan Municipality of Johannesburg. Region 6 shares its boundary with Region 10 to the east. Doornkop lies north-west of Dobsonville and south of the former Roodepoort City Council boundaries. There are 12 blocks with approximately 7000 formal stands, with one or more structures built on them. A squatter camp has been set up in Block 9 as a temporary housing measure. The housing backlog in Doornkop is 30,000 units. All stands are numbered, even in the squatter camp. It is estimated that there are approximately 60,000 people living in the area (see Figure 1).

Figure 1. Map of Doornkop, Soweto.

The residents were active and vocal during the apartheid era, as well as during the formation of the new government, especially in demanding their rights to access fundamental services and infrastructure. General poverty levels have been officially acknowledged in government reports. The majority of households are state-owned and are rented to the occupants. They consist of three- or four-room dwellings and only a small proportion have amenities such as indoor bathrooms and toilets. They rarely have a bathroom, and fresh water is provided by an outside tap, with a small toilet in the back yard; subsequently, local citizens combined to resist the new system of water-service delivery [32]. The inability to pay became a threat to accessing water [24] and cost recovery was exacerbated by water losses due to old infrastructure in the area. The overriding market logic to ensure cost recovery led Johannesburg Water to introduce a different approach to managing water-service delivery.

In 1995 and 1996, two surveys were conducted in the formal and informal settlements by the Greater Johannesburg Transitional Metropolitan Council in collaboration with the Community Health

Department of the University of the Witwatersrand to determine the basic needs of the Doornkop community [33]. Data were collected on housing materials, energy use, water, sanitation and refuse removal [34].

Most of the dwelling units in both formal and informal areas were made of corrugated iron. Originally, the water supply consisted of one standpipe in the street for 14 settlements. Just over half of the sample in the formal settlements (65%) had piped water from a tap, usually an illegal connection, and 42% used communal taps for obtaining water. Most residents (96%) of the informal area used communal taps for their water supply [33]. In 1998, a non-flush septic tank system was the major form of sanitation for the formal areas.

Residents complain that these overflows are not emptied often enough and are regarded as a health hazard, and consequently those without septic tanks have hired "Easy Loos" (chemical toilets), at a cost of R100 per month. Some residents in Block 5 have paid R2000 for a connection to the mains sewerage system and those in the less formal sector and the squatter camp use home-made pit latrines for sanitation [34].

In order to monitor progress in basic service delivery, a survey was undertaken in 1995 to ascertain people's perceptions of service improvements in basic services and water [35]. The majority of respondents perceived little change in the quality of services in their area [36]. The most problematic service issues for black respondents were electricity, water, toilets, health services and street lighting [37]. Interviewees felt that service issues were related to electricity cuts, overloads and lack of statements. Sharing of taps, queuing for water, no water supply in houses, insufficient public water-supply points and supply interruptions without warning were the major reasons for dissatisfaction with water among the interviewees. Not having indoor flush toilets, distance to toilets, lack of privacy, blockages, leaks and odour were the main problems experienced with toilets [36].

1.2. Delivering Water Services: From Traditional Water Management and Water Governance to Human Water Governance

According to [38], millions of South Africans are still dependent on water from open streams, boreholes or stagnant sources. Inequalities in water supply and sanitation, and lack of legitimate ways to claim rights to services, define the new water framework to manage water issues [39].

A new ethical view on managing water policies must be addressed by meeting social needs at communities [40]. It is based on lived experiences of inequitable water access [20]. Ethics, thus, play an important role in connecting water decisions to these perspectives by providing reasons and justification through the views of the population [41].

Through working group meetings, UNESCO examined the issue of water access and water sanitation under the auspices of the World Commission on the Ethics of Science and Technology (COMEST) and the International Hydrology Programme (IHP) in 1998. The sub-commission of COMEST eventually argued that, rather than repeating the analysis of the ethical issues of water management, it should try to promote principles [42]. Such principles will not only effectively guide human behaviour at informal settlements but also encourage the government to introduce ethical rules as standard [43].

UNESCO has provided a group of principles not only to improve the way communities are governed through philosophies of management but also to make better individuals by enhancing human values. We have structured these principles in three main categories: HWP, such as: human dignity and human equality; and PWM, such as: participation, empowerment, stewardship, inclusiveness and transparency. Both categories refer to WP, such as: quantitative and qualitative assessment, frugality, healthy environment, user pays and polluter pays [42].

1.2.1. Human Water Principles (HWP)

Human Water Principles (HWP), composed by Human Dignity (HD) and Human Equality (HE), are commonly described as communities and individual rights to live in a healthy environment [44,45].

This can also be understood as a wider concept in terms of human capabilities, as the right of individuals and communities not to be disenfranchised, thereby increasing their capabilities and overall welfare.

Basically, human principles are the grounds of human rights. The human right to water is derived from the International Covenant on Economic, Social and Cultural Rights (ICESCR), articles 11–12 [46]. Human principles provides the right to an adequate standard of living. Some rights are acquired, for instance by contract between individuals and organizations, while others are derived from the fact that we are human. They are called natural rights or simply human rights, which are intrinsic to every human being.

Therefore, when the UN Human Rights Council recognised the "human right to access safe drinking water and sanitation", this right remains inviolable and inalienable as a human right even if dismissed or restricted by governments or a community. The right is associated with the dignity of the people related to their "intrinsic worth". It is not only access to water but also to equality in the use of common goods [47]. Justice and equality are not merely about ensuring everyone's access to human rights to water but also reflect the notion of a human development approach to resources such as water. Moreover, there are different understandings of what justice is, depending on each individual conception of equal distribution [48] which implies an equal allocation of material goods to all society, and the concept of equality of opportunities [49] that reflects the notion of any distribution of resources [50].

The equality of opportunities and fair process of water distribution links directly to fair access to water and sanitation services. Issues can affect the dignity of the community, such as: communal taps, inefficient wastewater sanitation based on the bucket system at night; emptying bucket waste in the street or communal toilet safety at night need to be tackled. With regards to equality in providing water services, it is relevant to study the transparency in publishing water information of governments at a municipal level in order to promote water saving and conservation methods when necessary, and to engage the community to pay not merely the normal rate when water and a toilet is provided, especially when they produce pollution discharged into the surrounding environment (e.g., natural water courses).

At some stage, the lack of adequate access to water and water sanitation in the community can anger individuals [51], resulting in a lack of respect towards others, which means reducing the sense of self-respect that is so important to the integrity of every human being. The lack of social cohesion and inequality when providing equal water services to communities can also turn into a lack of cooperation between community residents and the Municipality [52].

1.2.2. Principles of Water Governance (PWG)

In that cooperation system, dwellers can engage with decisions by local government through a participation process in water decision-making. Whereas participation encourages all individuals to be involved in the consultation process for water planning and management [53], empowerment means building collective transformative capacity, being engaged in meetings where the water decisions are taken.

Adding to participation and empowerment, the stewardship principle protects the use of water. This protection and careful use of water resources promote the sustainable use of life-enabling ecosystems, such as water leakages and recycling the water that informal dwellers use [54].

In South Africa, community participation in services to communities is outlined by the Constitution of South Africa (1996) [55], (Act 117). Informal organisation or democratically-elected ward committees are crucial for upgrading and capacity building to be engaged by the local government for public services [56]. Ward committees operate on annual plans/programmes, affording members the opportunity to plan proactively and source funding, as well as support for planned programmes and projects. The involvement and participation of communities and sectors in slums can also be developed by an integrated development plan (IDP), which can be made public via local press, organisational infrastructure and public notices in public spaces that encourage participation of the widest possible section of the community in all local languages simultaneously.

Finally, through transparency, the municipality can also improve water management. This principle makes data accessible for dwellers, for example the handing of the budget and indigent policy allocated to water and water sanitation to community dwellers.

1.2.3. Water Principles (WP)

Water principles are also crucial to provide accurate, reliable and updated data on water bodies by the municipality. The UN, through the Universal Declaration of Human Rights (UDHR), pointed out that each individual is a subject of law. Rights can be applied when water services are offered in housing through an application to the municipality, but not when it is provided via communal services. It is understandable that, as users of nature, humans should pay (users pay) a royalty or fee for using natural resources. This payment will depend on the categories of customers; users, types and levels, and quantities of services; infrastructure requirements and geographic areas; which may justify the imposition of differential changes [57]. As a communal service, informal dwellers are not subjected to make the payment as long as the water services are not provided individually.

However, in terms of risk pollution, whether the customer receives water services in housing or communal services, everyone must be aware of it. Although most of the pollution problems derive from communal services, others can be attributed to domestic sources. As a preventive tool to mitigate environmental damage, polluters' payment has gradually extended to cover the costs of pollution prevention.

The challenge lies in how to focus attention on slums/informal settlements in a solution-oriented way. It is argued by [58] that if we are to start imagining a new human development trajectory, we should abandon the thought that slums should be eradicated, but rather, start to think in terms of adequate shelter for everyone or sustainable human settlements [59]. Therefore, assessments must combine sustainable and economic issues with social distribution and welfare goals but form part of a broader effort to achieve equitable access thereto, and efficient use thereof. This water principle allows the municipality to inspect the current water problems, regardless of whether they are related to sustainability or linked to economic variables.

This allows us to define the long-term strategic policy based on not only being respectable to the environment, but also to the use of water in excess of actual needs (frugality).

2. Methodology

2.1. Experimental Design and Hypotheses for the Study

Two steps were taken in order to organise this research. First, the definitions from the UNESCO's Water Principles were adapted to the sphere of impoverished South African settlements. Second, the experimental hypotheses were defined.

First, to adapt the definitions from the UNESCO's Water Principles to the sphere of impoverished South African settlements, six interviews were conducted with community leaders in focus groups in Doornkop (Soweto). Second, the focus groups were divided into to a relocated group, a tenure group and a squatter group. Third, the meaning of the aforementioned principles was discussed in order to include all the water issues raised by the experts. A broad definition was drawn up and approved by most of the participants based on the UNESCO Water Principles. Fourth, the questions were eventually resolved (Appendix A).

Repeated cross-sectional, longitudinal, intervention-based research was used. Comparisons were made between those previously mentioned groups. Based on the literature review, human water policies were set up to be proposed to the municipality such as: eliminating communal taps or providing alternatives to eliminate bucket waste in the street or providing safety when residents go to the communal toilets at night; these will help to develop the Principle of Water Management or Water Principles. It was expected that addressing basic human issues by the municipality would

positively affect the participation, empowerment, inclusiveness and transparency of decision taken by community in response to the water policies of the municipality.

Hypotheses were designed in order to reduce social, cultural, economic and normative inequalities among communities [60] by improving the living conditions. We were interested in demonstrating whether these three groups of water management could enhance impoverished dwellers' living conditions. We were interested in demonstrating if the Human Water Principles (HWP) or either "Human dignity" (HD) and/or "Human equality" (HE) improve the Principles of Water Governance (PWG) and Water Principles (WP) in order to enhance impoverished dwellers' living conditions (HWG).

1. H_1—Improving Human Dignity in water issues will affect positively the Principles of Water Governance (PWG).
2. H_2—Improving Human Dignity in water issues will affect positively WP compliance.
3. H_3—Improving Human Equality will affect positively the Principles of Water Governance (PWG).
4. H_4—Improving Human Equality will affect positively WP compliance.
5. H_5—PWG will enhance the community's living conditions through Human Water Management (HWM).
6. H_6—WP will enhance the community's living conditions through HWM.

The aim of the model is twofold: First, to ascertain the degree of importance informal dwellers give to crucial water issues; and second, whether the solutions to these water problems could improve the living conditions of these informal dwellers.

2.2. Model Development

The model was developed following the objectives of the paper: going beyond traditional water management and social and environmental water governance means that the "human right approach" is considered as a pivotal issue to build an ethical view of water management.

From UNESCO's principles (COMES, 2010) a model has been built based upon the opinion of the impoverished communities. It was developed to analyse if the two human-based principles (HD and HE) pointed out in the study would help not only to design the PWG and the WP, but also to improve the community's living conditions.

Following the hypotheses, Figure 2 shows the five latent variables: HWM, PWG, WP, HD, HE.

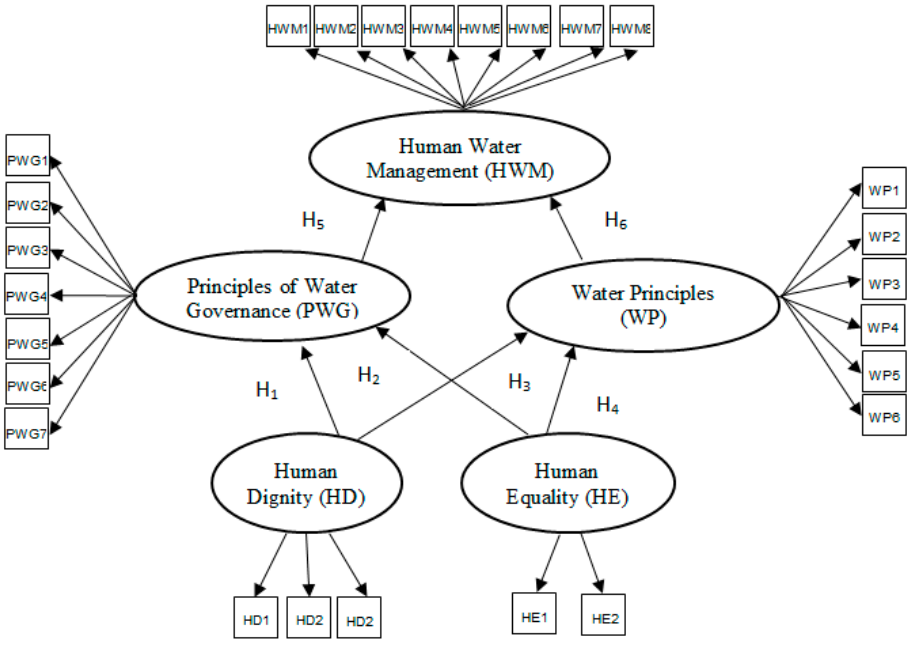

Figure 2. Human Water Management (HWM): a model to improve the living conditions of informal dwellers.

2.3. Sample

Each item is scored from 1 (very dissatisfied) to 7 (very satisfied) and combined. Scores gave an overall classification of personal principles which are intrinsic for the community sense of accomplishment.

Simple sample size calculations were carried out using the statistical package Smart PLS. The settlement numbers of all households were obtained from the housing department (Western Metropolitan Substructure, currently Region 6) due to them being relocated. There were 222 settlement numbers. Two random samples of 250 settlement numbers were drawn from the squatter area in Block 9 and Blocks 1–12 (tenure allocated group). IsiZulu was the most frequently spoken language (45%) followed by SeSotho (25%) and isiXhosa (13%).

First, a research co-ordinator and three trained and paid multilingual fieldworkers (residents of Doornkop) administered the questionnaire to the dwellers. Second, the research co-ordinator was responsible for the fieldworkers and the quality of data collection. The questionnaire was administered during the period January–May 2017. Finally, according to the population of these three groups, "relocated", "tenure" and "squatter", the questionnaire was delivered to 416 informal dwellers (125 relocated group, 162 tenure group and 129 squatter group).

2.4. Data Analysis

Structural equation modelling (SEM) is often used in market research because it can test theoretically supported linear and additive causal models [61]. Unobservable constructions or groups of variables are hard to measure. However, these latent variables can be used in SEM. Based on this methodology, the partial least squares–structural equation modelling (PLS–SEM) method seems to be ideal to measure those variables through variance.

This is a highly recommended method for exploratory research and allows the modelling of latent constructions with formative and reflective indicators [62]. PLS–SEM has already been applied to water research analysis related to water saving [63] and the provision of ethics in water management [64] in order to predict attitudes related to ethical behaviour and their impact on the community.

In addition, PLS is appropriate when the aim is to predict and to carry out research relative to new phenomena [65].

3. Results and Discussion

3.1. Demographic Information

The unemployment rate was 52% in 2017 at Doornkop. From the 416 informal dwellers interviewed, 41% were supported by a partner or relatives, 40% supported themselves by casual labour and 19% were supported through a pension scheme from the government. The average age of the interviewees was 37.9 years. This was consistent with the low level of pension support. The high level of unemployment among all four groups, coupled with the increasing reliance on casual labour, was a cause for concern, making skills-training and job creation a major priority for residents in these informal settlements.

The demographic information related to the participant's gender, age, main occupation, education and earning per months is provided in Table 1.

Table 1. Demographic information.

	Total (N = 416)	
	N	**Percentage (%)**
Gender		
Male	191	46.2%
Female	224	53.8%
	416	100.0%

Table 1. *Cont.*

	Total (N = 416)	
	N	**Percentage (%)**
Age		
25 years or younger	83	20.0%
26–44 years old	141	33.9%
45–59 years old	108	26.0%
60 years old and above	83	20.0%
	416	100.0%
Main ocupation		
Self-employed	182	38.0%
Employed: private companies	42	8.0%
Employed: public companies	16	4.0%
Unemployed	176	50.0%
	416	100.0%
Education		
No formal education	120	29.0%
Primary school	142	34.0%
Secundary school	49	12.0%
Matric	37	9.0%
Technical college certificate	24	6.0%
Technikon certificate or diploma	17	4.0%
University certificate or diplom	14	3.0%
University degree	13	3.0%
	416	100.0%
R per months		
R 1–R 800	115	28.0%
R 800–R 1600	141	36.0%
R 1.601–R 3.200	80	19.0%
R 3.201–R 6.400	45	11.0%
R 6.401–R 12.800	21	5.0%
R 12.801–R 25.600	14	1.0%
More than 25.600	0	0.0%
	416	100.0%

3.2. Analysis of the Measurement Model

The first aim of the model is to measure if the indicators that compose each construct are reliable. Each indicator has been previously ascertained among the leader of the community through the questions established in the questionnaire. Each construct was set with reflective indicators. This means that they "reflect" the reality of each latent variable or construct.

The first analysis of the measurement model was the individual reliability of the loads. If the indicators are relevant for the construct its loads (λ), as part of the construct, must be $\lambda \geq 0.707$ [66]. Table 2 shows that all values exceeded this minimum load, so indicators properly reflect each construct. This means that indicators have been rightly defined among the community and the author and, therefore, those indicators are measuring the reality of the latent variables at Doornkop.

Second, after measuring the reliable relationship between each indicator and the construct (HWM, PWG, WP, HD and HE), the construct reliability or the consistency is analysed among indicators. That means that it evaluates how rigorously the manifest variables or questions are at measuring the same latent variable or construct. If indicators are similar in their scores, they will effectively define the construct. The consistency of each construct was measured through its composite reliability (CR), which should be >0.7 [67]. As we can observe in Table 3, the latent variables have reached CR values above the lower limit of 0.7.

The validity of the construct is also measured from the indicator rho A. This tells us about the consistency of the constructs and their indicators. This would also be valid for values >0.7 [68]. The values for Table 2 are also higher than 0.7 for the four water latent variables. Thus, it was

possible to measure the rigour with which these items measure the same latent variable or construct. This evaluation measures the consistency of a construct based on its indicators.

Table 2. Loads (λ) of the item with the construct.

Indicators	Human Water Management	Human Dignity (HD)	Human Equality (HE)	Principles of Water Governance (PWG)	Water Principles (WP)
HWM_1	0.823				
HWM_2	0.816				
HWM_3	0.833				
HWM_4	0.821				
HWM_5	0.876				
HWM_6	0.798				
HWM_7	0.815				
HWM_8	0.811				
HD_1		0.852			
HD_2		0.930			
HD_3		0.930			
HE_1			0.912		
HE_2			0.900		
PWG_1				0.725	
PWG_2				0.852	
PWG_3				0.873	
PWG_4				0.845	
PWG_5				0.852	
PWG_6				0.930	
PWG_7				0.913	
WP_1					0.909
WP_2					0.909
WP_3					0.901
WP_4					0.958
WP_5					0.908
WP_6					0.777
					0.749

CR is also measured through the average variance extracted (AVE). This is defined as the average extracted variance and it reports how much variance is explained by the indicators rather than by the error [69]. Authors specify that an AVE $\geq$0.50 means that more than 50% of the variance of the construct is a result of its own indicators. All three statistics suggest that the constructs are well explained by the indicators. If this was not the case, it would have to be concluded that the indicators not define appropriately the constructs. New variables would have to be defined in that case.

Table 3. Consistency and average variance extracted (AVE) of each latent variable.

Latent Variables	Composite Reliability (CR)	rho_A	AVE
Human Water Management (HWM)	0.940	0.939	0.774
Human Dignity	0.912	0.931	0.890
Human Equality	0.909	0.911	0.887
Human Water Principles (HWP)	0.981	0.924	0.720
Principles of Water Governance (PWG)	0.955	0.945	0.775
Water Principles (WP)	0.945	0.942	0.799

As the relationship among indicators and constructs is being studied, the next statistic is based on the correlation among constructs. The third factor is the discriminant validity. This measures to

what extent a construct is different from others. As a strong point, PLS provides causal relations among constructs to explain why and how one construct affects directly or indirectly another construct. In our case, if the Human Water Principles (HWP) and either Human dignity (HD) and/or Human equality (HE) improve the Principles of water governance (PWG) and Water principles (WP) to enhance impoverished dwellers' living conditions (HWG).

Before analysing the strength of the relations among construct it is important to know whether the relationship is positive among them. For this test, the longitudinal data must be higher in its relations with another construct. In other words, the square root of the mean extracted variance (AVE) must be greater than the relationship between the construct and the rest of the constructs of the model [69]. This means that constructs should share more variance with their measures or indicators than with other constructs in a given model [70]. In our case, this condition is true for all latent variables, as can be observed in Table 4. Therefore, it can be concluded that constructs are able to be correlated one to another, although we do not know yet the strength of this correlations.

Table 4. Discriminant validity based on the Fornell–Larcker criterion.

Latent Variables	HWM	HD	HE	PWG	WP
HWM	0.821				
HD	0.499	0.899			
HE	0.499	0.448	0.823		
PWG	0.425	0.138	0.145	0.870	
WP	0.614	0.290	0.290	0.253	0.811

3.3. Structural Model Analysis

The next step is to know the quality of relations among constructs, and if the causal connections among them is strong or weak. This helps to make future predictions based on this type of connectivity of the model. We then need to study all the relations between the dependent or endogenous variables and the independent or predictor variables.

Standardised path coefficients (β) provide the extent to which predictor variables contribute to the explained variance of endogenous variables. The analysis of the strength or weakness of relationships among path coefficients and their statistical significance also allowed us to compare the proposed research hypotheses defined in the methodology. It is considered by [61] that a value of β is acceptable if it is greater than or equal to 0.2, although it is desirable to be above 0.3.

In our case all the six hypotheses are fulfilled, even though not with the same intensity. As Table 4 shows us there are a strong causal influence of HD into PWG and WP, and the influence of HE into PWG and WP. As a result, it can be said that the human rights approach of the model presented in the paper is highly valuable for designing how Principles of water governance and the Water principles have to be understood in Doornkop.

At the same time, the goodness of fit is measured from the t-statistic. From this, the following values are used as a reference of statistical significance: t = 1.647 for 95% confidence, t = 2.333 for 99% and t = 3.106 for 99.9%. The values reached in this test, along with the standard regression coefficients, have been collected and allow the hypotheses of the proposed structural model to be contrasted*.

The result shows significant data in Table 5, since all the hypotheses supported by the research are carried out at a 99.9% confidence level from H1 to H4 and 99% in H4, and H5. This reflects the strong influence of Human Dignity not only in PWG (β = 0.422; t = 4.756) but also in the Water Principles and Human and Water Principles (β = 0.465; t = 4.511). Similarly, Human Equality is highly related to the Principles of Water Governance (β = 0.450; t = 4.388) but also in the Water Principles and Human Water Principles (β = 0.390; t = 3.965). The remaining hypotheses presented lower, but equally, significant values. Thus, PWG has a positive influence on HWM (β = 0.227; t = 2.144), and PWG to HWM (β = 0.230; t = 2.139), with H1 and H2 being also fulfilled. This means that all the correlations

among constructs are highly valid. Therefore, as we pointed out in the objective of the paper, living conditions at the community are caused by proper attention to Human Dignity and Human Equality, either by the municipality or the dwellers.

Table 5. Coefficients path and statistical significance.

H	Hypotheses	β	Statistic t	*p*-Value	Supported
1	HD ≥ PWG	0.422	4.756	0.000	Yes ***
2	HD ≥ WP	0.465	4.511	0.000	Yes ***
3	HE ≥ PWG	0.450	4.388	0.000	Yes ***
4	HE ≥ WP	0.390	3.965	0.000	Yes ***
5	PWG ≥ HWM	0.227	2.144	0.009	Yes **
6	WP ≥ HWM	0.230	2.139	0.008	Yes **

Notes: For n = 5000 subsamples. Based on Student's t (499) distribution of a queue: * $p < 0.05$ (t (0.05; 499) = 1.64791345); ** $p < 0.01$ (t (0.01; 499) = 2.333843952); *** $p < 0.001$ (t (0.001; 499) = 3.106644601).

Structural analysis was performed through path coefficients β on each construct. This shows significant data, since all the hypotheses supported by the research were carried out at a 99.9% confidence level from H_1 to H_4 and 99% in H_4, and H_5. This reflects the strong influence of Human Dignity not only in PWG (β = 0.422; t = 4.756) but also in the Water Principles and Human and Water Principles (β = 0.465; t = 4.511). Similarly, Human Equality is highly related to Principles of Water Governance (β = 0.450; t = 4.388) but also in Water Principles and Human Water Principles (β = 0.390; t = 3.965). The remaining hypotheses presented lower, but equally, significant values. Thus, PWG has a positive influence on HWM (β = 0.227; t = 2.144), and PWG to HWM (β = 0.230; t = 2.139), with H1 and H_2 being also fulfilled.

3.4. Predictive Relevance and Effect Size

The coefficient of determination (R^2) represents a measure of predictive power, which indicates the amount of variance of a construct that is explained by the predictive variables of such an endogenous construct in the model.

The results obtained (see Table 6) indicate that the model explains 52.9% of the total variance, since the main endogenous variable of the model, Human Water Management (HWM), presents a value for R^2 above 33% and therefore, its level of explanatory power is moderate [65]. The other endogenous variables, Principles of Water Governance (PWG) and Water Principles (WP), explain 43% and 50.1% respectively of the total variance, and therefore they are significant (Chin, 1998).

Table 6 also reports the predictive relevance (Q^2) of the endogenous latent variable. The Q^2 values of 0.02, 0.15 and 0.35 denote small, medium and large predictive relevance [71]. Human Water Management (HWM), Principles of Water Governance (PWG) and Water Principles (WP) were found to have large predictive relevance, as reported Q^2 values are greater than 0.35. Therefore, the research model has a material predictive power in explaining Human Water Management (HWM).

Table 6. Value of endogenous variables.

	R^2	Q^2	f^2 *
HWM	0.529	0.354	-
PWG	0.430	0.477	0.226
WP	0.501	0.498	0.147
HD	0.000	0.000	0.196
HE	0.000	0.000	0.187

* HWM is the dependent variable.

Effect sizes reflect the statistical power of the research model, and there are two types of them. Effect size (f^2) assesses the extent of contribution that an exogenous latent variable makes to the R^2 value of an endogenous latent variable. The effect sizes of the endogenous latent variables are measured in Table 6. The results indicate small effect size f2 > 0.02 [72]. This value may be explained because the sample was small in relation to the population at Doornkop, which it is considered around 15,900 dwellers.

4. Conclusions

The conclusions from this research apply not only to academics but more importantly to practitioners and decision-makers working at impoverished settlements as is the case in this study, Doornkop. This study and the method presented in it can be transferred to other regions of the world which present similar characteristics.

The study highlights the importance of an ethical perspective to deal with water issues. Even though the vast majority of the studies are based on technical and environmental aspects of accessing to water and sanitation, this paper delves into a new approach based upon the improvement of living conditions at an impoverished community and the casual factors directly or indirectly related to it.

As UNESCO analysed in 2010, the improvement of water issues goes in the same direction as human ones more generally. The results obtained in this research show that water is respected when community dwellers and the municipality prioritize the development of Human Water Principles through Human dignity and Human equality. This means that is vital to have a plan to reduce inequalities and to promote dwellers' human dignity.

The moderate predictive power [61], with which the latent variables explain 52.9% of the total variance, allows us to affirm that the methodology followed in fixing indicators and constructs can be applied to other communities.

The paper, therefore, proposes a new model for understanding both traditional water management and water governance. It means that economic, infrastructural and social issues that float around the access to water and sanitation are not enough for tackling water problems in impoverished communities.

Human dignity and human equality not only have become pivotal issues for addressing social ones at Doornkop but also allow them to understand why they must respect water in their community. We can affirm based upon the findings of this research that informal dwellers not only are willing to be engaged in water decisions, but also to report water leakages as well as recycle the water, if a municipality is determined to improve human dignity and human equality. This means that the local administration must go ahead not only in eliminating communal taps, buckets and ablution toilets, but also in providing information about water issues such as budget, indigent policy, and assisting residents in water saving and conservation methods. All these measures taken by the municipality will help impoverished dwellers to pay the normal rate when water and toilets are provided in their houses, or to mitigate environmental damages. Those water challenges can, therefore, guide water policy in the Johannesburg Municipality.

In other words, this model, based on improving water management but also enhancing individuals, is capable of leading water decision-making. The future decisions taken by the municipality in Johannesburg can address human dignity and human equality as major factors to be taken into account.

In a nutshell, rather than solving the water challenges by confronting access to adequate clean water or wastewater sanitation in mixed or informal settlements by improving the material conditions and government interventions [7], it is important to consider other indicators. These will not only improve water management but will also enhance individuals whose living conditions are extremely poor. As the population of Doornkop has expressed, it is urgent to tackle these inequalities regarding access to water and water sanitation, measuring every single year the indicators that Human Water Management have rightly provided. These measures will enhance the provision of appropriate wastewater services to every single human being.

A new methodology has been provided in this research as a response to the lack of water solutions to improve the living conditions of impoverished South African settlements, which go beyond traditional water management or water governance. However, as the sub-commission of COMEST argues, rather than analysing once again the ethical issues of water management, a new approach should try to promote principles [42] which need to be measured in time. The municipality and informal dwellers play a crucial role in order to improve not only water services but also individuals. Although the research needs to be tested several times in order to analyse the evolution of the results, it provides the main indicators by which the municipality can take future decisions.

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Appendix

Table A1. Latent variables and elaborated questionnaire.

	Latent Variables	Questions	Authors
1.	HD in water issues	Is it important for you to eliminate the bucket if you use it at night and the emptying of the bucket waste in the street? (HD_1)	Gumede & Mokoena, 1999; Westaway et al., 1998
		Is it important for you communal taps in your community? (HD_2)	
		Is it important safety for you when you or residents go to the communal toilets at night? (HD_3)	
2.	HE in water issues	Is it important for you that the municipality provide the same water and wastewater sanitation in Doornkop, as it is the case in the rest of Johannesburg? (HE_1)	Bakker, 2007; Bond and Dugard, 2008; McCleave et al., 2003; Reed, 2008
		Is it important for you that the municipality provide equal systems of payment at Doornkop compare to the rest of Johannesburg? (HE_2)	
3.	PWG: Participation Empowerment Inclusiveness Stewardship Transparency	Attending the water basic issues by the municipality will encourage you to participate in the IDP meetings or local street committee meetings on water issues? (PWG_1)	Reed, 2008
		Is it important for you to participate in your ward meetings in discussing water issues? (PWG_2)	
		Is it important for you to be involved in deciding the water tariffs with the municipality? (PWG_3)	
		Is it important for you to report water leakages to the water committee in your street to be reported to the Municipality? (PWG_4)	
		Is it important for you to recycle the water that you use? (PWG_5)	
		Is it important for you to be informed about the Indigent Policy? (PWG_6)	
		Is it important for you to know the budget allocated to water and water sanitation in Soweto before Council approve the Budget? (PWG_7)	

Table A1. *Cont.*

	Latent Variables	Questions	Authors
4.	WP Assessment User pays Frugality Polluters pays Healthy environment	Is it important for you that the municipality inspect the state of access to water and water sanitation? (WP_1)	Dugard, 2010
		Is it important for you that Municipality assist you with water saving and conservation methods? (WP_2)	
		Is it important for you to pay the normal rate when water and toilet is provided in your house? (WP_3)	
		Is it important for you to remain in a shack so that you do not pay for water services? (WP_4)	
		Is it important for you not to develop sanctions for the polluters? (WP_5)	
		Is it important for you that the Municipality provide a good sanitation services? (WP_6)	
		Is it important for you not to throw bottles, papers, nappies in the street or river or storm-water drains? (WP_7)	
		Is it important for you to have a healthy environment in order to avoid diseases (WP_8)	
5.	HWM	Eliminating communal taps, bucket and ablution toilets would improve your living condition? (HWM_1)	Gumede & Mokoena, 1999; Westaway et al., 1998; Reed, 2008; McCleave et al., 2003; eed, 2008; Sanoff, 2000; Xie et al.,2014
		Receiving water services as other communities in Johannesburg would improve your living condition? (HWM_2)	
		Being engaged in water decisions would improve your living condition? (HWM_3)	
		Reporting water leakages and recycle the water would improve your living condition? (HWM_4)	
		Providing by the Municipality information about water issues such as budget, indigent policy, would improve your living condition? (HWM_5)	
		Assisting you in water saving and conservation methods by the Municipality would improve your living condition? (HWM_6)	
		Paying the normal rate when water and toilet is provided in your house would improve your living condition? (HWM_7)	
		In order to mitigate the environmental damages, do you think that to pay for contaminating the environment would improve your living condition? (HWM_8)	

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